APPENDIX B. SQUAW CREEK STREAM SURVEYS

Squaw Creek Reach 1

Incision: 2 meters (6.6 feet)
Width: 2 meters (6.6 feet)
Bankfull Width: 3meters (9.8 feet)
Substrate: silt and riprap
Gradient: <1%

Shallow depth, lack of cover, and high levels of fine sediments limit the habitat potential for salmonids in Reach 1 of Squaw Creek. Streambed substrate is composed of silt and riprap. No pools are present in the reach, and glides and slow riffles dominate the habitat. The few pieces of LWD do not create significant pockets of scour or pool habitat. The entrenched nature of the channel and revetted streambanks preclude development of off-channel habitat. A waterfall created by a concrete retaining wall between the Brooklane Drive Bridge and the Mary's River poses a complete barrier to the upstream migration of fish.

Squaw Creek Reach 1 is a channelized, heavily altered section of stream. Both streambanks are armored with class 200 (3.3 meter [1-foot mean diameter]) riprap throughout the entire reach. The stream course in this reach appears to have been straightened and closely parallels Brooklane Drive to the west. The aquatic habitat in the reach is dominated by slow glides. Small areas with higher flows are created in places where the riprap confines flows, giving the appearance of riffle habitat. The streambed is composed of a mix of silt and riprap.

The riparian area along Reach 1 is confined by Brooklane Drive to the east and agricultural lands and a residence to the west. The riparian overstory is patchy and less than 50% of the channel is shaded. Riparian trees include red alder (*Alnus rubra*), big-leaf maple (*Acer macrophyllum*), Oregon ash (*Fraxinus latifolia*), and willow (*Salix* sp.). Himalayan blackberry is the dominant shrub species. Dense thickets cover the banks in places where the overstory is open or incomplete.

Squaw Creek Reach 2

Incision: 2 meters (6.6 feet)
Width: 3.5 meters (11.5 feet)
Bankfull Width: 4.5 meters (14.8 feet)
Substrate: silt and clay
Gradient: less than 1%

The lack of riffle habitat and instream cover, as well as poor substrate quality and high turbidity, in Reach 2 limit the suitability of Reach 2 for salmonid rearing or spawning. Slow flowing, shallow glides and deeper slack-water pools are the dominant habitat types in this reach. Long slack-water pools are created by debris jams. The depth of these pools averages about 0.6 meter (2.0 feet). The glide habitat is considerably shallower, averaging approximately 0.2 meter (0.7

foot). Almost no riffle habitat exists in this reach because the stream lacks the gradient necessary for riffle formation. Large woody debris is scarce in the wetted channel, but several large logs are perched over the incised channel. The substrate is composed entirely of clay, silt, and riprap that has fallen into the stream from makeshift bank revetments.

The channel in Reach 2 is deeply entrenched and moderately sinuous. The banks in the reach are composed of a slightly erodible clay layer beneath a highly erodible layer of topsoil. Overall, the streambanks in the reach are mostly stable. However, small areas of the bank have eroded at channel bends and the small private bridges.

The riparian zone of Reach 2 consists of a mix of disturbed areas dominated by dense patches of blackberries and forested areas with native tree and understory species. The overstory vegetation shades approximately 75% of the stream channel. Overstory species include white oak (*Quercus alba*), Oregon ash, Douglas fir (*Pseudotsuga menziesii*), and big-leaf maple. Understory species include hawthorn (*Crataegus* sp.), snowberry (*Symphoricarpos albus*), and Pacific ninebark (*Physocarpus capitatus*).

Squaw Creek Reach 3

Incision: 0 to 1.5 meters (0 to 4.9 feet)
Width: 1.5 meters (4.9 feet)
Bankfull Width: 5 meters (16.4 feet)
Substrate: silt and gravel
Gradient: 1%

A mix of glide, riffle, and pool habitats characterizes the aquatic habitat in Reach 3. The gravel in the reach is highly embedded in fine sediment and not suitable for salmonid spawning. Very little LWD and no pools deeper than 0.6 meter (2.0 feet) are present in the reach. Consequently, instream cover for fish is lacking.

The incision in the reach is variable. At the top of the reach, just downstream from 35th Street, the channel is incised approximately 1.5 meters (4.9 feet). No low terrace or floodplain is present to help dissipate the energy of high runoff events. The stream appears to be down cutting and undercutting portions of the bank causing large chunks of the bank to collapse into the stream. As the stream approaches Knollbrook Place, the banks are laid back and the channel is wider. The gently sloping banks and narrow floodplain in this section of stream are better able to handle high flows without experiencing bank erosion or increased channel incision. Near the bottom of the reach, the channel again becomes incised.

The riparian areas in this reach are generally narrow and confined by development. Large portions of reach have few, or no, trees along the south streambank. As a result, the riparian canopy shades less than 50% of the channel. Himalayan blackberries (*Rubus discolor*) and reed canarygrass (*Phalaris arundinacea*) are the dominant species along the stream. Tree species include Oregon ash, willow, and an assortment of introduced species and ornamentals planted on

properties adjacent to the stream. Native shrubs (hawthorn, snowberry, and Pacific ninebark) are present in the forested stream margins.

Squaw Creek Reach 4

Incision: 0.5 meter (1.6 feet)
Width: 2.0 meters (6.6 feet)
Bankfull Width: 2.0 meters (6.6 feet)
Substrate: silt, clay, and organics
Large Woody Debris: 4 pieces

Reach 4 is approximately 210 meters (700 feet) long. It is located between the confluence of the north and south forks of Squaw Creek and the 35th Street stream crossing. The habitat consists of slow-moving glide-like habitat and three short riffles. The substrate is composed entirely of sand and fine sediments, except in the riffles where gravel-sized riprap dominates the streambed. The few pieces of LWD in the reach are small-diameter hardwood logs that create no significant instream cover.

Incision depth in the reach is approximately 0.5 meter (1.5 feet). The shallow incision of the creek allows over-bank flows to disperse onto the wide, flat, wooded wetland floodplain. Evidence of over-bank flows was observed in this reach. The flood plain is important to the hydrologic functioning of the creek as it disperses the energy of high flows and prevents deepening of the streambed and erosion of the banks. The lack of incision in Reach 4 may also be the result of the concrete box culvert located at the downstream end of the reach. The culvert appears to exert a hydrologic control that maintains the current channel depth, creating a non-erodible lower limit to channel incision.

The riparian area consists of flat, forested riparian wetlands. Residential development limits the width of the riparian buffer to approximately 20 meters (65.6 feet) on either side of the creek. The overstory vegetation consists of small and mid-sized Oregon ash. The forest canopy shades approximately 75% of the stream channel. The shallowness of the channel, lack of current, and mucky substrate combine to make Reach 4 unsuitable habitat for salmonid species.

North Fork Squaw Creek Reach 1 (NFSC 1)

Incision: 0.3 meter (1.0 foot)
Width: 1.5 meters (5.0 feet)
Bankfull Width: undefined
Substrate: silt and organics
Gradient: <1%

Reach 1 of the North Fork of Squaw Creek is a small, very low gradient stream channel. The stream is shallowly incised, allowing high flows to easily exceed the banks. Traces of ephemeral

side channels created by over-bank flows are visible in the flat wetland riparian areas adjacent to the stream. These riparian wetlands likely serve as water detention and storage sites by slowing and dissipating the energy of high flows and by storing runoff and allowing it to slowly percolate back into the stream. Small debris jams throughout the length of the reach impede flows and create backwater. During periods of high runoff, they likely dam the channel, causing water to flow into the riparian wetland areas.

Fish habitat in the reach is marginal. The lack of riffle habitat—approximately 95% of the habitat is glide-like—the high turbidity of the water, and the lack of coarse substrates combine to make the reach virtually uninhabitable for salmonids. Large woody debris' present in small amounts, mostly in the form of small debris jams. The small pockets of scour created by the debris jams are too small and shallow to provide adequate refuge to rearing trout or juvenile salmon.

North Fork Squaw Creek Reach 2 (NFSC 3)

Incision: 1-0.5 meters (1.6 to 3.3 feet)
Width: 0.8 meter (2.6 feet)
Bankfull Width: 2.0 meters (6.6 feet)
Substrate: silt and organics
Gradient: 1%

Fish habitat in Reach 3 is marginal. The water is shallow and slow moving with few pieces of large woody debris. It is turbid, allowing approximately 0.4 meter (1.3 feet) of visibility. Few pockets of scour are present, and fine sediments dominate the substrate. Riparian overstory is composed nearly entirely of Oregon ash. Willow is the dominant streamside shrub, and willow becomes a more dominant species in the upper portion of the reach.

A wide, flat wetland is located on the right bank just upstream from West Hills Road. The left bank riparian area immediately upstream from West Hills Road has been cleared to create a park-like picnic area for the church and school located approximately 100 meters (328.1 feet) to the west. Many of the riparian trees have been left standing, but the understory has been cleared and planted with a lawn. Upstream from the church, the riparian area is less disturbed for approximately 250 meters (820.2 feet), at which point agricultural fields and a tree farm impinge upon the channel and restrict the riparian area to a narrow band of trees and shrubs on either bank. The average width of the riparian area in this portion of Reach 3 is approximately 20 meters (65.6 feet).

Channel incision in Reach 3 is variable. In some stream segments, the channel is narrow and incised more than 1 meter. In other areas, streambanks are gradually sloped and incision is less than 0.5 meter (1.6 feet). The connection between the floodplain and the channel also is variable. In places with less incision, evidence of over-bank flows is present, whereas in areas with more incision, stream connectivity with riparian wetlands is less. Wetland floodplain habitat often is associated with the shallowly incised portions of the stream.

South Fork Squaw Creek Reach 1

Incision: 0.3 meter (1 foot)
Width: 1.5 meters (4.9 feet)
Bankfull Width: Not measured
Substrate: silt and organics
Gradient: <1%

Reach 1 of the south fork of Squaw Creek is a very low gradient channel with low banks and a wide wetland riparian area. The lack of gradient and stream energy combine to yield habitat that is dominated by glides, with very few riffles or pockets of scour. Small accumulations of woody debris create some instream cover and small areas of scour. Long woody debris is present in moderate quantities. Salmonid habitat in the reach is marginal because of the lack of flow, the shallowness of scour pools, the absence of coarse substrates, and questionable water quality.

The lack of incision (approximately 0.3 meter [1 foot]) and the wide, flat riparian wetlands appear to aid in flood storage and detention. Evidence of numerous ephemeral channels is common in the right bank riparian area. These indicate that over-bank flows are common and that runoff is being dispersed over the wetland areas adjacent to the stream rather than rapidly conveyed to the lower reaches. The diversion of flows into these areas stabilizes the hydrograph and decreases stream energy during high flows.

The riparian overstory shades approximately 85% of the channel near the confluence of the north and south forks. However, upstream from Country Club Place the overstory becomes patchy and in some places completely absent. The overstory in Reach 1 is composed entirely of Oregon ash. Understory vegetation is mostly herbaceous and composed of hydrophytic species such as rushes (*Juncus* sp.) and buttercup (*Ranunculus* sp.). Woody understory species include Indian plum (*Oemleria cerasiformis*) and Nootka rose (*Rosa nutkana*). Where canopy closure is sparse or absent, the dominant riparian species are grasses, sedges (*Carex* sp.), and willows.

A duck pond on the north side of the creek was identified as a source of nutrient contamination in the City of Corvallis' stormwater management plan (Watershed Applications 2000). A small pump has been set up in the stream near Starker Park to withdrawal water from the creek.

South Fork Squaw Creek Reach 2 (SFSC 2)

Incision: 0.6-1.5 meters (2.0 to 4.9 feet)
Width: 1.5 meters (4.9 feet)
Bankfull Width: 2.5 meters (8.2 feet)
Substrate: silt and organics
Gradient: 1%

Much of Reach 2 is confined by commercial and residential development. The riparian area transitions from the flat wetland habitat characteristic of Reach 1 to a more contained channel with sloping streambanks. Streambanks are human-constructed, with no riparian overstory

throughout most of the reach. Riparian vegetation is largely composed of willow, grasses, sedges, and rushes, including reed canarygrass, and cattail (*Typha* sp.).

Aquatic habitat in this reach is not suitable for salmonids, and creates a water quality concern for the rest of the stream. No riffle or pool habitats exist in these areas and the substrate is a mucky matrix of silt and organic debris. In many places, the channel is choked with aquatic macrophytes, rushes, and sedges. The abundant aquatic vegetation produces great amounts of organic material that may suppress dissolved oxygen (DO) levels as it decomposes. Dissolved oxygen levels likely fall below salmonid tolerances within the reach. The slow, smooth-flowing channel may not have enough riffle habitat to recharge DO levels to the water as it leaves the reach; therefore, DO problems may be transported downstream. If organic material transported from the reach settles in other low-energy stream reaches, it may also depress DO levels near the deposition sites.

Because sloping banks confine the channel, the reach provides only a small amount of water storage and detention. Moreover, the lack of overstory vegetation in much of the reach may contribute to elevated water temperatures downstream.

South Fork Squaw Creek Reach 3

Incision: 0.5 meter (1.6 feet)
Width: 1- 1.5 meters (3.3 to 5 feet)
Bankfull Width: 2.5 meters (8.2 feet)
Substrate: silt and sand
Gradient 1%

South Fork Squaw Creek Reach 3 is similar to Reach 1 but is somewhat narrower and has a less-extensive riparian zone. A wide, flat floodplain is located on either side of the creek. Much of this floodplain is mapped as wetlands (City of Corvallis 1999). The lower portion of the reach is well shaded by an overstory of Oregon ash. The stream appears to have been purposefully channelized near the 53rd Street crossing and the left bank riparian area has been cleared for commercial development.

Between the 53rd Street crossing and West Hills Road, the stream passes through mostly agricultural lands. The associated riparian areas are variable in width, ranging from more than 60-meter- (196.8-foot-) wide swaths of Oregon ash forest to 5.0-meter- (16.4-feet-) wide corridors of willow. Much of the stream is bordered by wetlands that may help stabilize flows in the creek by absorbing and storing water from high flows and gradually releasing it during dry periods.

Low flows, the lack of pool and riffle habitat, and the absence of suitable spawning substrates make the reach only marginally inhabitable for salmonid species. Slow, glide-like habitat dominates the reach, and the substrate is composed largely of silt and sand. High temperatures or channel desiccation may prevent fish from using this reach during the summer and early fall.

Watershed: SOUTH FORK SQUAW CREEK

Date: December 1997

Location: 152.4 meters (500 feet) of stream corridor immediately upstream from 53rd Street

Observations: The City requested that this area be evaluated because it was slated for future development. The stream and floodplain in this area consist of a wide, continuous riparian corridor of ash and hawthorn trees with considerable channel-spanning downed woody debris (mostly smaller material). The channel is not incised and the floodplain is essentially unconstrained and hydrologically connected to the channel, with no significant channel bed or bank erosion. A wide strip of ash woodland on the north side of the creek suggests that pockets of wetland are likely in this area, although most of the floodplain away from the channel does not appear to be jurisdictional wetland. This is a relatively diverse habitat area with good restoration potential. Canopy coverage is good and riparian and instream habitat value are moderate. Good channel/floodplain coupling suggests that much of the site is prone to flooding under high flow conditions.

Recommendations: Require wide streamside buffer strips to provide flood protection and wildlife habitat and to maintain channel shading as a condition of development.

Location: Straightened reach downstream from Technology Loop (183 meters [600 feet])

Observations: Stable but lacks visual interest. Habitat value could be improved.

Recommendations: The wide set-aside buffer area between the creek and the multi-unit housing complex on the right bank affords the opportunity to enhance this area as a model for both habitat and visual improvement. The creek could be at least partially re-meandered through this reach at relatively low cost (minimal earth movement required because the channel is not entrenched). Volunteer woody vegetation could be supplemented with limited plantings (using volunteer regrowth in the rehabilitation strategy). Structural habitat for both terrestrial (riparian) and aquatic species could be improved with the addition of salvaged downed woody debris. Much of this work could be done at low cost by community volunteers.

Location: Sunset Park, north of baseball fields (335.3 meters [1,100 feet] of channel distance, within a corridor width of 61 meters to 122 meters [200 to 400 feet])

Observations: The channel is not incised and the floodplain is not constrained through this large area, which includes significant amounts of native woody vegetation. Portions of the channel are lined with ash. The grassy swards and patches between woodland areas are mowed but provide no wildlife habitat. Nor do they provide an area for human use because of persistent wetness (much of this seasonally wet area appears to be jurisdictional wetland).

Recommendations: This substantial area of publicly owned open space affords the opportunity to implement a large, multi-functional stream corridor rehabilitation project at relatively low cost. This could be done by excavating multiple anastomosing (interconnecting) channels: relatively low cost is assured because the channel is not incised within its floodplain. In conjunction with grading, native riparian and wetland trees and shrubs and LWD accumulations could be installed throughout the area. This work could be conducted by community volunteers over several years. Ultimately, a low-impact boardwalk could be routed through a portion of the renaturalized area. Such a treatment would provide (1) some level of flood storage (through both an increase in capacity and enhanced floodplain roughness), (2) water quality improvement by the filtering of over-bank flows and shading in now sunny channel locations, (3) enhanced wildlife habitat, and (4) enhanced amenity and passive recreational opportunities. (Note that these alterations may require an upgrade of the culverts under Country Club Place since the road crossing is quite low.)

Location: Country Club Place downstream, south side of channel (152.4 meters [500 feet] of channel distance)

Observations: The lower part of this undeveloped area is quite wet (may be jurisdictional wetland) and the entire area appears to be abandoned pasture or hay meadow. The area is growing into thickets of native rose and ash saplings with swards of buttercup and rush in the wettest areas. It is traversed by several small, fast-flowing drainage ditches, which appear to originate (at least in part) from the golf course uphill from Country Club Drive. Thus, untreated and potentially contaminated runoff is discharged directly into Squaw Creek.

Recommendations: Additional flood storage could be provided in this area by mass excavation. A low-cost alternate project would be to de-channelize at least the lower ends of the ditches, allowing the water to spread out over the toe-slope wetland before reaching the creek. Constructing earthen, log, or rock sills along the slope contour would enhance this effect. Water spreading in this area would provide water quality filtering of the golf course runoff before it reaches Squaw Creek. It also would provide a small (but incremental) amount of runoff detention, contributing to reduced flood peaks. This work could conceivably be accomplished entirely by volunteer manual labor at almost no cost.

Location: Starker Arts Park Pond

Observations: High waterfowl use of this pond contaminates the water draining from the pond directly to the creek.

Recommendations: Convert the 30.5-meter- (100-foot-) long earthen ditch between the pond outlet and the creek into a broad vegetated bioswale with numerous log or rock sill drop structures.

Stewardship Opportunities: Community volunteers could potentially accomplish all of this work.

Location: Downstream from 35th Street at John Adams School (183 meters [600 feet] along the north side of the channel)

Observations: A considerable width of mowed grass in this streamside zone is apparently little used by the school because it is remote from school facilities and is persistently wet for most of the year.

Recommendations: Excavate a flood storage facility along the north side of Squaw Creek on John Adams School property. Re-meandering the straightened creek channel through this reach could be a part of this work, but is not mandatory. Tree and shrub plantings would be used to create a riparian fringe to the off-channel flood storage area; wetland plantings could be installed within the facility. In addition to being already owned public open space, the site affords obvious educational/volunteer opportunities.

Complementary work on the right (south) bank of the creek through this same reach could be accomplished on adjacent private property (church). Mowed grass on this property continues to the channel edge, which is over-steep and failing in places. Sufficient space is available to regrade the banks along the church property and install a functional woody riparian buffer here. At least one storm drain discharging from this property potentially could be daylighted and routed through a naturalized bioswale for stormwater pre-treatment. Constraint: Private ownership.

Location: Stream corridor several hundred feet up- and downstream from the Knollbrook Place Bridge.

Observations: Stream is not entrenched, generally only slightly incised (but becoming more incised at the downstream end), and only moderately confined by residential development (relatively wide setbacks). A narrow functional floodplain is colonized in its upper part by weedy grasses, but is joined along the lower part by relatively extensive stands of hydrophytic forbs such as sedges and buttercup. Canopy coverage is moderate (interrupted young stands of native riparian trees and shrubs along the south bank). Streambanks are silt/clay, with minimal bank erosion. Problem: Minor street flooding in this area.

Recommendations: Additional flood storage and improved habitat and aesthetic conditions could be provided in this area by relatively small-scale excavation to enlarge the floodplain area (accentuate the two-stage cross section). Machine access is good for this work. The opportunity for this is especially good upstream from the bridge, and especially on the north side of the creek. Minor channel re-meandering could easily be incorporated within this work, at relatively low cost. Additional woody vegetation plantings, especially on the south bank, would improve canopy cover.

Watershed: LOWER SQUAW CREEK

Date: 1999

Location: Entrenched meanders downstream from Knollbrook Place

Observations: Squaw Creek begins to develop more sinuosity downstream from the channelized reach in the vicinity of Knollbrook Place. On the other hand, the straightened channel segment at Knollbrook Place at least possesses a partially functional floodplain while the stream becomes progressively more entrenched and de-coupled from its floodplain below this area. A private road extends west from Brooklane Drive and services a few homes. This dead-end road borders the tight meanders of the creek and crosses the creek on wooden bridges at two locations. Bank erosion is occurring locally in the vicinity of the two bridges.

The channel in the area with a strongly meandering pattern is generally entrenched to a depth of 1.2 to 2.4 meters (4 to 8 feet). Active channel width in this area averages about 3.1 to 3.7 meters (10 to 12 feet), although some areas of the channel are narrower. Streambanks are generally very steep (often near vertical) but largely stable, being comprised primarily of clay. Very little woody debris is found below the mean water surface elevation because the channel through most of this area has a chute-like aspect with smooth clay banks. Most of the fine- to moderate-sized woody debris (including some larger logs) within this reach are stranded on the flat above the channel and are well out of reach of ordinary stream flows. These woody materials provide no instream habitat and thus the active channel itself exhibits low overall habitat complexity.

The streambed through this reach generally consists of clay, although demolition debris has fallen into the channel from homemade revetments. Rubble rock also has fallen into or been placed in the channel in places, such as around the bridges. Much of this very low-gradient reach is a slack-water glide 1 to 1.2 meters (3 to 4 feet) deep in which flow is barely perceptible during low-water conditions. Some of this backwater is attributable to debris jams that partly block the channel. The roughly poured concrete apron around the westernmost private automobile bridge also forces a long backwater pool.

Dense blackberry thickets border much of the creek in this reach, although the central part has an overstory of larger ash, oak, maple and alder trees. The understory here includes blackberry as well as a number of native shrubs, such as snowberry, serviceberry (*Amelanchier* sp.), oceanspray (*Holodiscus discolor*), hawthorn, Pacific ninebark, and hazel (*Corylus cornuta*).

Willow is locally abundant along the uppermost part of this reach. In this area, willow branches extend well below the top-of-bank. Minor floated debris accumulations were found throughout this reach when evaluated in August 1999. This is partly because the willow branches tend to capture flood-borne debris.

A prominent debris accumulation fully spans the channel in the vicinity of the Reed Place cul-de-sac. Fish passage through this area during low-flow conditions is impossible. The dam is formed from sediment, demolition rubble, and fine to coarse woody debris and apparently has persisted for some time because it has a willow sapling rooted in it. The top of the dam is about

0.6 meter (2 feet) above streambed grade. This deposit not only fragments aquatic habitat but is causing accelerated bank erosion in its vicinity. In a few other areas, large root structures also pinch down and entirely block the low-flow channel.

Along healthy, non-incised streams, such low-slung branches generally provide healthy riparian habitat. In this entrenched channel, neither the branches nor their accumulated debris is within the ordinarily flooded portion of the channel cross section. In a few places, some moderately sized branches and racked-up wood pieces nearly penetrate the water surface, but these provide only minimal instream cover. Because of the stream's entrenched condition, this material also tends to cause local channel erosion. Successive accumulations such as this may contribute to local backwater flooding in the vicinity of Knollbrook Place.

One apparently private water pump was noted on this reach of Squaw Creek. The pump appeared operational and probably is used for domestic irrigation. Private pumps are not a permitted use on many small urban streams.

Recommendations: Minor pruning of the overhanging willow branches along this reach could reduce the tendency for debris jams to occur here and perhaps alleviate flood impacts somewhat in the residential area upstream. Selective pruning of only the lowest branches would not impact habitat conditions because their removal would not affect channel shading or damage the plants. Very little of the debris hung up on these branches extends into the ordinarily wetted channel perimeter, but is instead left suspended above the wetted channel after flood recession. This captured debris (and the living branches that trap it) do not provide instream structural habitat: the debris is mostly fairly fine and perishable because it is transient (passing through during floods) and because even the larger wood pieces are only rarely in the water.

More permanent flood relief in the Knollbrook area might be achieved with some sort of high flow bypass through this area. Because stream gradient is low here, the resistance-to-flow imparted by the meander bends must form some component of the flooding in areas upstream. Such a high-flow bypass channel would not affect ordinary flows and could be enhanced as a habitat area within the riparian zone.

Location: Confluence with Mary's River through channelized reach

Observations: The confluence of Squaw Creek with the Mary's River at Brooklane Drive is impassable to fish in the absence of very high Mary's River flows backwatering up into this area. A 1.2-meter- (4-foot-) high concrete weir with a vertical face and no plunge pool (just angular boulders) is immediately downstream from the Brooklane Drive bridge. Flow goes subsurface in the steep, rock-filled channel from the weir downstream.

Squaw Creek makes a sharp turn immediately upstream from the bridge. This bend is fully revetted with quarried rock riprap. The stream has a nearly straight alignment for hundreds of feet upstream from this bend, having been channelized at some point in the past. This straightened and re-aligned reach still retains a generally trapezoidal cross section and is entrenched about 2.4 to 3.7 meters (8 to 12 feet) below the surrounding terrain. Channel gradient

is low and streambanks appear to consist mainly of silty clay, making them relatively resistant to erosion.

Confinement caused by entrenchment, as well as episodes of sediment deposition, have resulted in the formation of sporadic low flood benches only a few feet wide within this reach. This provides some incipient sinuosity to the low-flow channel in this otherwise straight channel segment. The low flood benches are stabilized mainly weedy forbs such as creeping buttercup and by alien grasses (especially reed canarygrass). Active channel width is about 3.1 to 3.7 meters (10 to 12 feet) but the low-flow channel often is considerably narrower than this because of the accreted benches. Where the channel bottom could be observed, it consisted of basalt boulders and rubble with heavy silt deposits. This suggests that the channel was lined with rock when it was constructed.

The bank slopes above the low-flow channel are at an angle of 1:1 or somewhat shallower and support mainly dense blackberry thickets which are penetrated here and there by relatively immature individuals of native woody riparian species, including alder, ash, oak, maple, and willow. However, these plants grow densely enough and are mature enough to provide moderately good shade to the channel, except in the reed canarygrass-dominated section just upstream from Brooklane Drive.

Floated tree limbs, medium-sized woody debris, and a few small logs become caught in the limbs of brushy vegetation growing along the lower banks and form occasional accumulations within this channelized reach. These cause local bank erosion while at the same time providing some instream habitat diversity. The presence of the flood benches also creates a deeper low-flow water column than would have been present just after channelization, thereby improving both stream temperature conditions and instream habitat. Nevertheless, channel habitat conditions must still be regarded as degraded, with poor opportunities for fish to hold in this reach during higher stream flows.

The general habitat conditions described above continue up through the broad bend and subsequent short, straight reach just below the “outlet” of the entrenched meanders (see below). However, tree growth becomes more mature in the upstream area (creating a more tunnel-like, shaded channel). The left (outside) bank in this area has been revetted with dumped rock and concrete demolition debris. A channel-spanning debris dam was located in August 1999 in this area (about 76.2 meters [250 feet] downstream from the easternmost private automobile bridge; see below). The deposit consisted of both sediment and small to medium-sized woody debris and formed a impassable fish barrier at this location. This deposit apparently resulted from the accumulation of flood-borne debris on a very low, sweeping willow trunk that partly blocks the channel here. The dam stood about 1.2 meters (4 feet) high above streambed grade.

Recommendations: In terms of immediate priority, the small debris jam just discussed should be removed unless higher seasonal stream flows have already done this. However, the structure appeared stout enough that it may persist through the high-flow period.

The entire designated reach down to the Brooklane Drive bridge is essentially free of encroaching infrastructure, making functional restoration in this area technically straightforward.

The undeveloped stream corridor width through this reach is generally on the order of several hundred feet. This would allow extensive bank slope reprofiling and functional floodplain re-creation along with stream re-meandering. Structural habitat improvements for instream cover could readily be built into the channel at this time. However, upstream development suggests fine sediment delivery would remain an issue in this reach insofar as instream habitat conditions are concerned.

A more restrained channel rehabilitation approach also is possible in this reach. This might entail removing the blackberry thickets, lowering bank angle to some degree (but preserving the native woody vegetation wherever feasible), accentuating the "apparent" sinuosity of the stream by widening the existing flood benches in a staggered pattern from bank to bank (while preserving a narrow low-flow channel), and replanting native tree and shrub vegetation along the upper bank slope. This could create a well-shaded but more open creek corridor in this reach. Structural habitat improvements to the low-flow channel also could be installed as a part of this more restrained approach.